THE EFFECT OF FEEDBACK ON RESIDENTIAL ELECTRICAL PEAKING AND HOURLY KILOWATT CONSUMPTION

An abstract of a Thesis by
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The problem. Electricity consumption research has primarily investigated procedures designed to decrease overall kilowatt hour (KWH) consumption. Only one study has reported the effects of a procedure on the pattern of electricity consumption. The present study assessed the effects of feedback on KWH consumption and the consumption pattern.

Procedure. The present study compared the effects of a feedback light and buzzer, which signalled high consumption in any 15 min period of the day, with an initial and final baseline period where no feedback was given. Three volunteer families served as subjects. Five measures of overall consumption were used.

Findings. Each consumption measure decreased during Feedback for all families. When feedback was withdrawn in the final Baseline period for two families, all measures from one family and one measure from the other family returned to the initial Baseline levels. The consumption pattern during Feedback remained unchanged in one family and changed in another family when compared to Baseline.

Conclusions. Feedback can decrease overall KWH consumption and change the consumption pattern.

Recommendations. Further research could assess the effects of other procedures on electricity consumption and identify other kinds of changes in the consumption pattern.

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Elbert Blakely

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

The cost of electricity generation has increased due, in part, to recent increases in the price of crude oil. New methods of producing electricity, that do not rely on crude oil, must be developed and implemented. In the meantime, electricity conservation is important to keep the production cost low and to provide time to develop the new production methods. Procedures need to be designed that will encourage consumer electricity conservation.*

An operant technology has been increasingly applied in analyzing environmentally related behavior. Behavior related to littering (Burgess, Clark, & Hendee, 1971; Chapman & Risely, 1974; Clark, Burgess, & Hendee, 1972; Hayes, Johnson, & Cone, 1975; Kohlenberg & Phillips, 1973; Powers, Osborne, & Anderson, 1973), paper disposal (Geller, Witmer, & Orebaugh, 1976), purchasing returnable bottles (Geller, Farris, & Post, 1973), and noise reduction (Meyers, Artz, & Craighead, in press) have been modified. Savings in residential fuel oil (Seaver & Patterson, 1976), natural

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gas (Winett & Nietzel, 1975), residential electricity (Hayes & Cone, in press; Kohlenberg, Phillips, & Proctor, 1976; Palmer, Lloyd, & Lloyd, in press) and gasoline consumption (Foxx & Hake, 1977) have been demonstrated using operant techniques.

Behavioral research on electricity conservation in private homes has investigated two problem areas: methods of decreasing overall electricity consumption and methods of reducing peak demand. Peak demand usually refers to the high electricity use during certain times of the day.

Prompts in the form of slogans and letters (Palmer et al., in press) and daily feedback on KWH consumption or cost information to individual consumers (Hayes & Cone, in press; Palmer et al., in press) have decreased overall daily KWH consumption. Monetary rebates, contingent on decreased consumption, have also been effective (Hayes & Cone, in press; Winett, Kagel, Battalio, & Winkler, in press; Winett, Kaiser, & Haberkorn, 1976). Simply giving information to the consumer on how to save electricity or listing the wattage of various appliances (Hayes & Cone, in press; Winett et al., in press) and weekly consumption feedback (Winett et al., in press) have not been effective in decreasing overall consumption.

The second problem area in electricity research and production, reducing peak demand, is important since supplementary generators using expensive oil or nuclear power must be operated during peak demand periods. During non-peak periods, the supplementary generators are idle. It would be more cost efficient, from the electricity producers' point of view, if some of the peak demand could be eliminated and/or switched to non-peak periods of the day. Initial research in this area demonstrated that feedback given every 15 min and feedback plus monetary rebates were effective in reducing peaking with residential consumers (Kohlenberg et al., 1976). Specifically, this research showed that cumulative KWH above a criterion could be reduced in private homes. It did not reveal whether there was an overall KWH reduction, whether consumption was switched to non-peak periods of the day or how much, if any, of the decrease occurred during the peak demand hours of the day. The present research obtained data on these possible outcomes.

Most studies of overall and peak consumption have involved electricity consuming behavior not related to air conditioner or furnace operation. In the only study conducted during humid summer days using families with air conditioners (Winett et al., in press), monetary rebates were effective and weekly feedback was ineffective in reducing consumption. A point system with backup reinforcers was effective in reducing the duration of small appliance use in an individual home (Woodarski, Note 2), but did not reduce furnace use. It was noted that weather variations confounded the furnace use data. Some procedure that will decrease overall consumption and/or reduce peaking with heating and cooling devices must be developed and evaluated.

The present study was conducted during the summer months with families who had air conditioners. The effects of 15 min feedback on overall consumption and on peaking during a season when air conditioners were in use were studied.

Chapter 2

METHOD

Subjects

Permission was obtained from the owner and the manager of an apartment complex in Des Moines, Iowa, to contact residents in the complex by telephone. Eleven families were contacted. Two families volunteered to participate. A third family in a private home also agreed to participate. The criteria for selection of the families were that the residence was equipped with air conditioning, that one parent functioned as a houseperson (she/he was not employed elsewhere), that at least one child lived in the family, and that the family would not leave for an extended vacation during the study. Each family had an electric stove, electric refrigerator, television, radio, dishwasher, and a central air conditioning unit. The apartment families did not have individual water heaters, washers, or dryers. The private home contained a water heater, washer, and dryer.

Apparatus

Each family dwelling was equipped with a feedback device and a recording device. The feedback device consisted of a chassis box, a 7W light bulb, and a 6 volt buzzer. The 7W bulb was mounted in a hole drilled in the box. The 6 volt buzzer was mounted inside the box. The feedback device was mounted on a wall between the living room and kitchen of each dwelling.

The recording device, mounted at the dwelling's electric meter, included an Esterline-Angus 15 min cumulative watt recorder, a standard electric clock, and a counter. The cumulative watt recorder recorded the KWH consumed during every 15 min period of the day. This recorder consisted of an upward moving pen that reset to zero every 15 min. The resulting raw data were strip charts containing 96 upward sloping lines for each day. The height of each line represented the KWH consumed in a 15 min period. Recorders were equipped with electrical contacts that could be adjusted to close when the pen excursion reached a predetermined position; i.e., a predetermined 15 min consumption level. The contacts re-opened when the pen reset to zero at the end of the 15 min interval.

The counter and clock were wired through the contacts to a 110 volt power source. When the contacts closed, the counter pulsed and the clock operated continuously until the pen reset to zero. The recorder also activated the feedback device inside the dwelling. The contacts pulsed the buzzer and operated the 7W light bulb continuously until the pen reset to zero. When the family consumed the predetermined amount of electricity in a 15 min period, the buzzer pulsed and the 7W light bulb was operated until the 15 min interval ended. When the buzzer and light bulb were operated, the family's electricity consuming activity had no effect on the feedback device within that particular 15 min interval. The watt recorders operated at all times during the study. The dependent variables obtained throughout the study were the KWH consumption per 15 min period and per 24 hours, the number of peaks (the number of times that 15 min consumption reached criterion), and the duration of peaks per 24 hours (cumulative minutes in each 15 min period that the pen was above the criterion). KWH above criterion data were calculated after the study ended.

Procedure

This study was scheduled to begin in mid-April and end in August. Due to equipment shortages, the study did not begin until July. Observations were conducted for 65 days.

Instructions to subjects. Prior to the beginning of the study, each family was told that their electricity consumption would be continuously measured by recording equipment, that at 8 p.m. each day, an experimenter would collect data from the recording device and that the feedback device would operate at various times during the study. Thus, a recording day was from 8 p.m. on a particular day to 8 p.m. on the following day. The relation between the feedback device and KWH consumption was also explained.

Experimental conditions. Families were alternated from Baseline to Feedback and back to Baseline conditions. The private home family, Family 3, did not receive the final Baseline condition. The unforeseen delays in beginning the study resulted in an overlap with Family 3's vacation. During Baseline, subjects were informed in writing that the feedback device was disconnected. Strip charts were removed from the recorders after nine days of Baseline. A criterion of peaking was chosen for each family such that 10% of the strip chart lines for all nine days were above the peak level. These criterion peak levels were not changed for the remainder of the study.

During the Feedback condition, families were informed in writing that the feedback device in their dwelling would be operating whenever their consumption during a 15 min interval reached a peak level. The contacts of the watt recorders were set to close at each family's designated criterion peak level. If a peak occurred during any 15 min interval, the feedback light would remain on until the end of that interval regardless of any changes in electricity usage by a family member. The study was terminated when the days began to cool in early autumn. The number of days in each condition and the number of days on vacation for each family are in Table 1 (columns 2, 3, 4, and 5).

Reliability. A second observer independently collected data on six occasions during the study. Reliability

Table 1

The number of days in each condition, the number of days on vacation, the number of days with a median dew point of 60° or above (humid days) in each condition, and the number of days that equipment failed for each family

Family	Number of days: In each condition: Baseline	Feed-back	Reversal	On vacation	With median dew point of 60° or above (humid days): Baseline	Feed-back	Reversal	Equipment failed
1	34	19	12	2	18	12	4	0
2	27	9	29	0	16	3	15	3
3	32	33	0	5	18	16	0	0

for each dependent measure was calculated by dividing the smaller frequency by the larger frequency and multiplying by 100. Agreement was always 100%.

Chapter 3

RESULTS

Electricity demand during the summer in Des Moines can be largely attributed to air conditioner operation (Fletcher, Note 1). Des Moines summers are warm and especially humid. The temperature and the amount of moisture in the air were important in analyzing the data. The amount of moisture in the air is indicated by dew point. Dew point is the temperature at which a parcel of air must be cooled to form water. The higher the dew point, the more water in the air. Dew point in Des Moines' summers generally varies from 40° on dry days to 70° on extremely humid days. As the present study progressed, it became evident that extreme fluctuations in temperature and particularly dew point generated corresponding fluctuations in the electricity consumption data. Peaks per day varied from zero on cool, dry days to 20-30 on warm, humid days. Days with zero or few peaks which were correlated with low temperature and dew point readings could not contribute meaningful data to the study. Consumption would probably have been low on such days regardless of the experimental condition in effect. The median daily dew point and the number of peaks for all days in all conditions for all families are shown in Figure 1. Visual comparison of the increases and decreases of both dew point and peaks indicates a positive

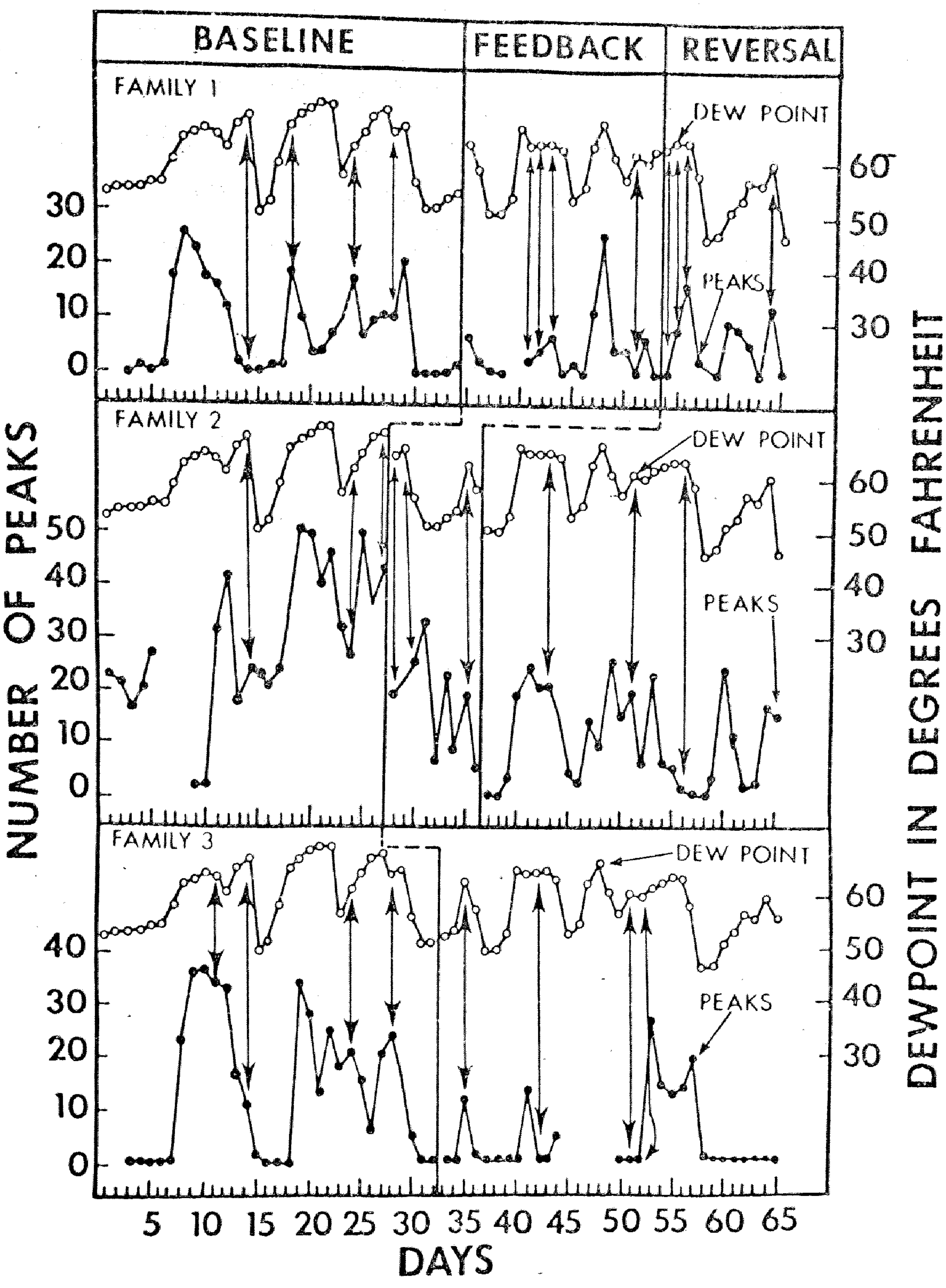

Figure 1. The number of peaks and the median dew point for all days of the study for all families. The arrows indicate the days that the judges selected as being equal with respect to dew point.

correlation between the two events. Pearson product moment correlations between daily dew point and number of peaks during Baseline were 0.52, 0.45, and 0.65 for Families 1, 2, and 3 respectively. Dew point was clearly predictive of electricity consumption on a particular day.

For the purpose of the present study, data from warm, humid days were more important than data from cool, dry days. In order to eliminate the data from cool, dry days, a criterion for humid days was selected. Freese-Notis Associates, Inc., a private weather forecasting company in Des Moines, has advocated a criterion for humid days as a day with a dew point of 60° Fahrenheit (16° Centigrade) or above. Iowa Power and Light Company has accepted this criterion. It was used in the present study. Only days that had a median dew point of 60° or above were considered. The number of humid days remaining in each condition for each family after the cool, dry days were eliminated from consideration are shown in columns 6, 7, and 8 of Table 1.

When electricity consumption for only humid days was plotted, there was still considerable variability in the day to day consumption. An additional selection procedure was employed in a further effort to decrease variability in the data. In the additional selection procedure, the dew point at 8:00 a.m., 12:00 noon, 4:00 p.m., and 6:00 p.m. of each humid day were plotted. (See Figures 4, 5, and 6 in the Appendix). These times were recommended by Iowa Power and

Light Company as the times when people often choose to turn on their air conditioners. Judges (psychology faculty and graduate students) selected four dew point curves in each experimental condition which they judged most similar to each other (only three humid days were available during Feedback for Family 2 so the judges chose three curves in each condition). At least 80% of the judges chose a particular set of curves for Families 1 and 2. Eighty percent of the judges did not agree on any of the curves for Family 3 so the four curves that the raters chose most often were used. The same procedure was repeated using temperature data.

Because of the low agreement among judges for Family 3, another procedure for selecting comparable humid days was examined. The median temperature and median dew point for each day were summed. Five days were chosen in each condition that were most comparable with respect to the combined temperature and dew point. This procedure was then used to select four days per condition for Family 1 and three days per condition for Family 2.

In summary, a fixed number of days were chosen from each experimental condition to form three sets of data that were comparable with respect to dew point, temperature, and a combination of both. The selected days for each family were not always the same as the selected days for the other families. The electricity consumption data for the three weather criteria were next plotted for the selected days. All three weather criteria generated similar sets of consumption data. Since the dew point readings were particularly useful in predicting electricity consumption throughout the study, the dew point criterion was adopted for the analysis of the results of the present study. The arrows in Figure 1 indicate those days selected by the judges to be equal with respect to dew point (e.g., days 14, 18, 24, and 28 during Baseline for Family 1).

The consumption data equated for dew point are shown in Figure 2. There are five sets of histograms in three rows for each family. The top row of histograms contains the mean dew point recording (open histograms and right hand ordinate) for the four (three for Family 2) selected humid days for each of the families during each experimental condition. The top row of histograms also shows the mean daily KWH (shaded histograms and left hand ordinate) consumed by each family during the different experimental conditions. The second row of histograms shows the mean peak duration (shaded histograms and left hand ordinate) and the mean KWH consumption over the peak criterion (open histograms and right hand ordinate) by the families during each experimental condition. KWH consumed above the peak criterion was calculated after the study ended for only the selected humid days. The third row of histograms shows the mean number of peaks for each family during the experimental conditions.

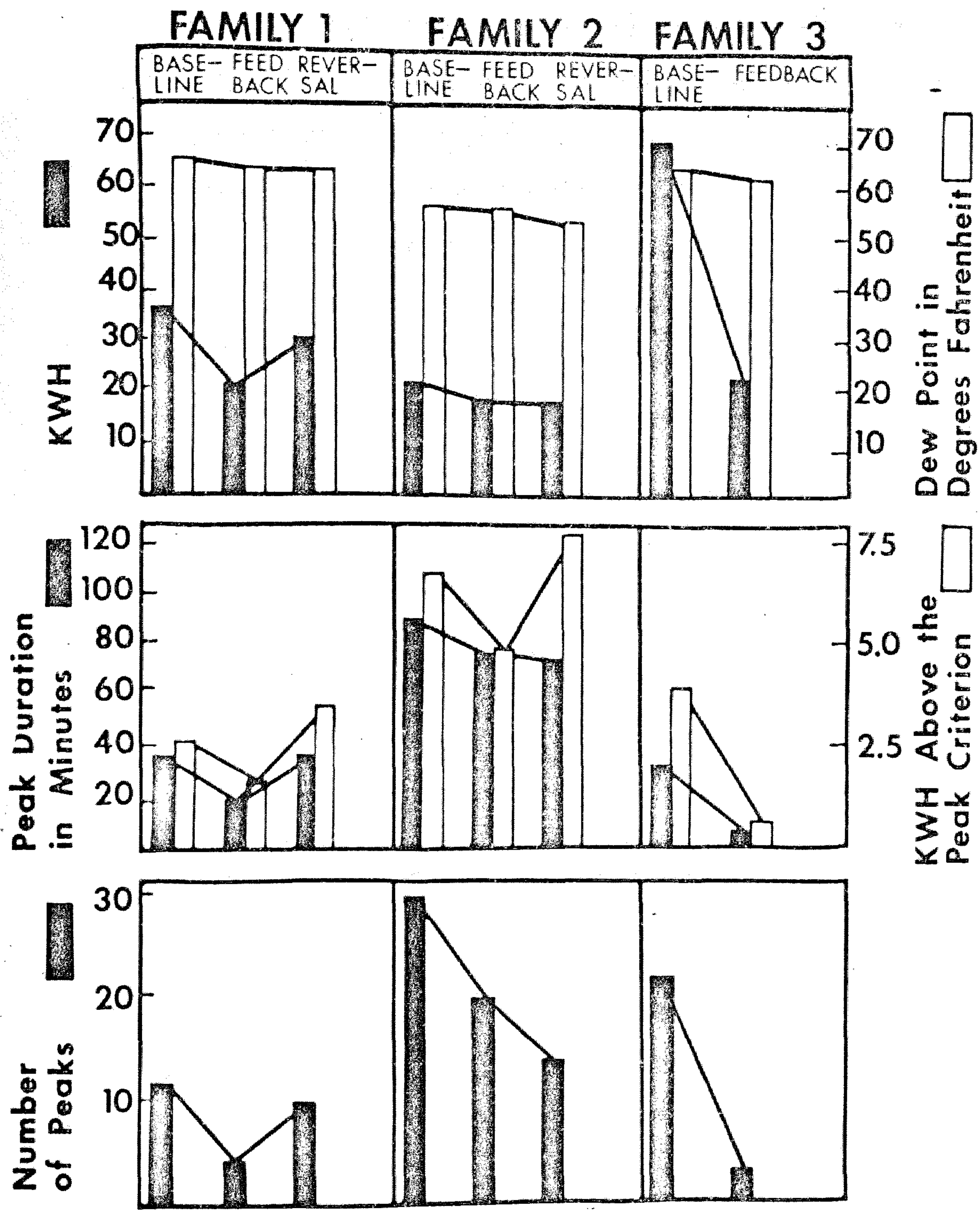

Figure 2. Mean equated KWH consumed, dew point, peak duration, KWH above peak criterion and number of peaks for all conditions in each family for dew point equated days.

The data from Family 1 in Figure 2 clearly demonstrates the effectiveness of the feedback procedure in reducing consumption as compared to Baseline and Reversal in terms of all four dependent measures. The data from Family 2 show a decrease in consumption during Feedback for all dependent measures. Only KWH above the peaking criterion increased during Reversal for this family. The data from Family 3 show a decrease in consumption during Feedback for all four dependent measures.

Figure 2 includes only data from the selected days. The mean KWH consumed, the mean peak duration, and mean number of peaks were also calculated for all days (both humid and cool days) of each condition for each family. These means were then adjusted for dew point variability using analysis of covariance. Table 2 contains the means for selected days, for all days, and the adjusted means. The adjusted means (and the means for all days) change in the same direction across the experimental conditions as the means for selected days with the exception of the mean peak duration for Family 1. The selected days data in Figure 2 represented, on the whole, the data from all days, even when the total days data were adjusted for changes in the dew point. Table 3 shows the analysis of covariance results using the KWH per day, peak duration per day, and the number of peaks per day data for the Baseline and Feedback condition for each family. The Baseline and Feedback

Table 2

The mean KWH, mean peak duration, and mean number of peaks in each condition for each family. The means are calculated for the selected days and for all days of the study. The means for all days were corrected for changes in dew point to generate the adjusted means

	Mean KWH			Mean Peak Duration			Mean Number of Peaks		
	Base-line	Feed-back	Reversal	Base-line	Feed-back	Reversal	Base-line	Feed-back	Reversal
Family 1									
selected days	36	21	30	35	19	34	12	4	10
all days	30	23	23	19	18	22	8	5	6
adjusted	29	23	26	17	20	24	7	5	8
Family 2									
selected days	22	18	17	90	76	74	31	20	14
all days	21	16	13	161	77	40	29	18	10
adjusted	20	15	12	147	84	45	28	17	9
Family 3									
selected days	69	22	-	33	6	-	22	3	-
all days	51	27	-	23	6	-	13	4	-
adjusted	48	31	-	19	10	-	11	6	-

Table 3

The results of each analysis of covariance (F ratios, degrees of freedom, and significance levels) using KWH/day, peak duration/day, and peaks/day for each family. The Baseline and Feedback condition data were used in each analysis of covariance.

Family	KWH/day	Peak duration/day	Peaks/day
1	$F = 2.59$ $df = 1,48$ $p > .05$	$F = .25$ $df = 1,37$ $p > .05$	$F = 1.36$ $df = 1,48$ $p > .05$
2	$F = 3.12$ $df = 1,30$ $p > .05$	$F = 2.73$ $df = 1,21$ $p > .05$	$F = 3.06$ $df = 1,30$ $p > .05$
3	$F = 9.70$ $df = 1,57$ $p < .01$	$F = 4.93$ $df = 1,47$ $p < .05$	$F = 4.50$ $df = 1,57$ $p < .05$

means are not significantly different for Family 1 and Family 2 ($p > .05$). The means for Family 3 are significantly different ($p < .05$ for peak duration/day and peaks/day; $p < .01$ for KWH/day).

The hour by hour demand curves for electricity for each experimental condition on the selected humid days for each family are shown in Figure 3. The data for these median hourly demand curves were obtained by first summing the four 15 min KWH consumptions for that hour for each humid day. The high points in these curves correspond to the demand peaks previously discussed. For Family 1, the Feedback condition resulted in a decrease in consumption for all 24 hours when compared to Baseline. During Reversal, there was an increase in consumption during 21 of the 24 hours as compared to Feedback (note the three exceptions at 10 a.m., 11 a.m., and 12 noon in Figure 3). For Family 2, consumption in Feedback decreased from Baseline in 17 out of 24 hours and increased in 10 out of 24 hours during Reversal when compared to Feedback. For Family 3, both consumption and peaking decreased in all 24 hours during Feedback as compared to Baseline. Iowa Power and Light Company reports that the peak demand hours for the Des Moines community are from 8-11 a.m. and from 5-9 p.m. Using only these selected nine peak demand hours, for Family 1, consumption in Feedback decreased from Baseline in all nine hours and consumption in Reversal increased from Feedback in seven of nine peak hours. For

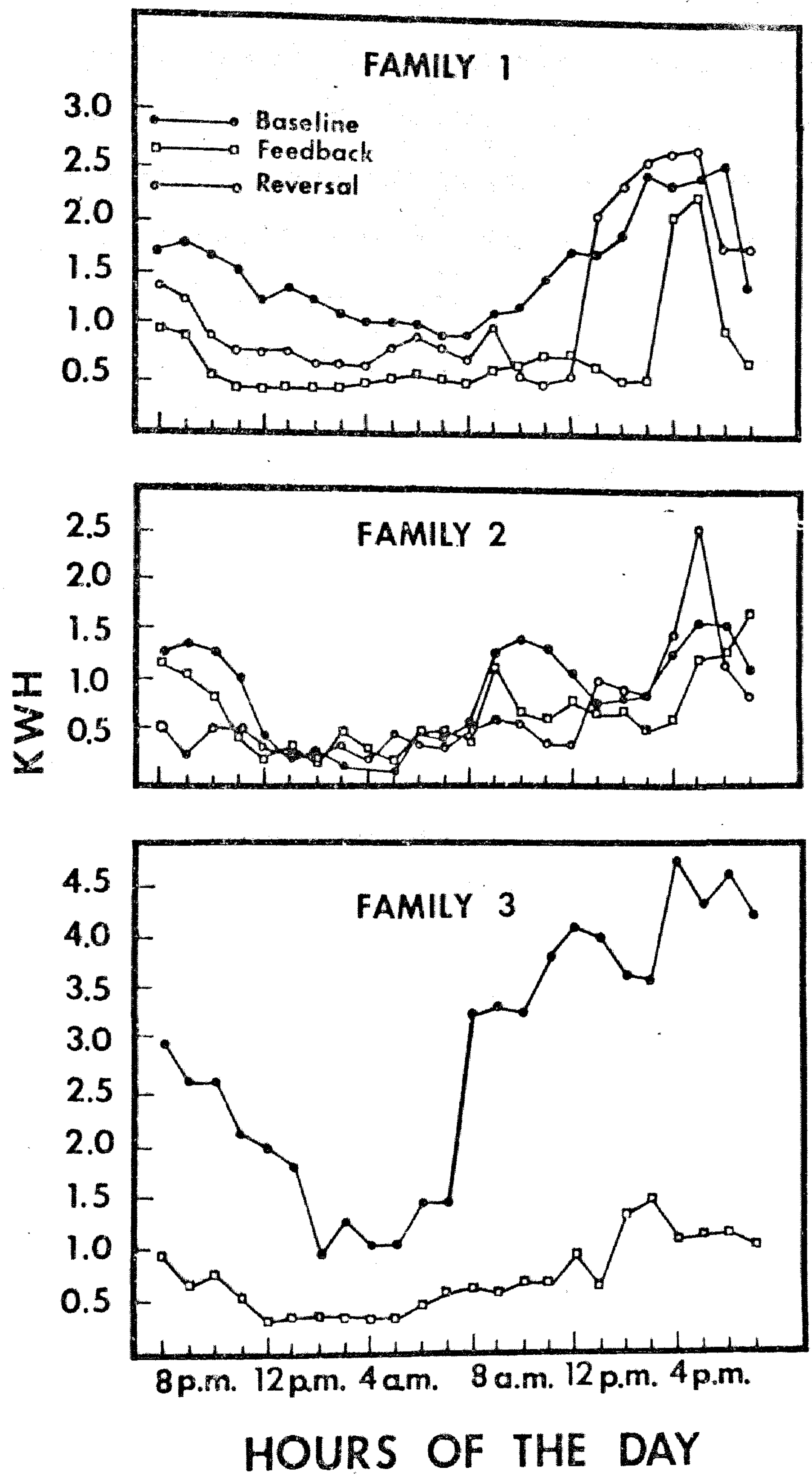

Figure 3. Median KWH consumption per hour of the day for all humid days for the three experimental conditions in each family.

Family 2, consumption in Feedback decreased from Baseline in eight of nine peak hours. Consumption in Reversal increased from Feedback in three of nine hours. For Family 3, consumption in Feedback decreased from Baseline in all nine peak demand hours.

At the end of the study, each family verbally responded to a questionnaire. All families reported that they had no objection to the feedback device being in their homes and that the feedback device helped them conserve electricity. Families 1 and 2 said that they did nothing in particular to conserve electricity. Family 3 reported turning on the fan to circulate the air instead of turning on the air conditioner.

Chapter 4

DISCUSSION

The data in Figure 2, Table 2, and Figure 3 indicate that feedback can be effective in reducing electricity consumption on humid days in individual homes. Consumption decreased from Baseline to Feedback in all dependent measures in all families. All the Reversal data from Family 1 and the KWH above peak criterion reversal for Family 2 support the interpretation that the Feedback condition was responsible for the decrease in consumption. The houseperson (the husband) in Family 2 moved out of the apartment during the study. An important electricity consumer was not at home during the day for the last part of the study. This could explain the continued consumption decrease in three dependent measures during the Reversal condition. A second possibility could be that a smaller electricity bill as a result of reduced consumption during Feedback maintained the low consumption. Although it was not possible to obtain Reversal data from Family 3, the large magnitude of the decrease in consumption from Baseline to Feedback in all four dependent measures (Figure 2) and the clear change in the slope of the hourly demand curve (Figure 3) strongly suggest the effectiveness of the Feedback condition.

The present data replicated the effects of feedback on KWH consumption above a peak criterion (the only dependent variable reported by Kohlenberg et al., 1976). Both studies used a feedback light that operated when the electricity consumed in a 15 min. period reached a criterion. This study added a buzzer to the feedback device. The present data extended the Kohlenberg et al. (1976) data by indicating that feedback can reduce other dependent measures; namely, KWH per day, peak duration, and peaks per day. It was also demonstrated that feedback could decrease consumption in both non-peak hours and peak hours of the day. The data from Family 2 showed that changes in the mean KWH above peak criterion do not necessarily indicate corresponding changes in other measures such as mean KWH per day, peak duration, peaks per day or the consumption pattern. The Family 2 data question the utility of mean KWH above a criterion as the only dependent measure. In the present study and probably in the Kohlenberg et al. (1976) study, once consumption in any 15 min interval exceeded criterion the feedback light came on and remained on until the end of that 15 min interval. Ideally, the feedback light should have been constructed to go off immediately after someone in the household reduced consumption to below criterion. Given such an arrangement, the overall effects of feedback would probably have been even greater in both studies.

The effects of the 15 min feedback on KWH per day were similar to the effects of daily feedback on overall KWH consumption (Hayes & Cone, in press; Palmer et al., in press). Neither of these studies had been conducted during the summer, so the effects of daily feedback on electricity consumption due to air conditioner operation could not be assessed. Weekly feedback (Winett et al., in press) was found to have no substantial effect on electricity consumption where the major part of the consumption consisted of air conditioner operation. The present research is the first report of the effectiveness of feedback in reducing electricity consumption related to air conditioner operation. Perhaps more immediate feedback, i.e., 15 min intervals rather than weekly intervals, is necessary to effect changes in air conditioner use on humid days. Research is needed to compare the relative effects of weekly, daily, and 15 min feedback procedures.

The high variability in peaks per day in Figure 1 also occurred in other dependent measures. Variability of this nature is typical of many electricity consumption studies. Some of the variability may be a function of corresponding changes in the dew point. In the present study, days that were similar with respect to dew point were selected in each condition; thus, changes in the data could not be a result of changes in the dew point. The fact that dew point appears, in part, to determine air conditioner use on humid days suggests that a dehumidifier might be used in homes instead of an air conditioner. Dehumidifiers remove moisture from the air and use 50-60% less electricity than air conditioners.

The hourly demand curves in Figure 3 show Baseline peaking periods around 4:00 p.m. and non-peaking periods around 4:00 a.m. The pattern of these curves could have changed in at least three ways when the families were shifted from Baseline to Feedback. Only two such changes occurred in the present study. During Feedback, the overall shape of the demand curve could remain similar to Baseline with the entire curve being lower on the ordinate (see Family 1 in Figure 3). During Feedback, the demand curve could have become flatter and at a lower level on the ordinate (see Family 3 in Figure 3) or at the same general level such that total KWH per day remained the same as in Baseline. This third possibility did not occur in any of the families. Further research is needed to identify the kinds of changes in demand curves, like those in Figure 3, most likely to occur with changes in experimental conditions.

The term peaking is used differently in different contexts to describe periods of high electricity consumption. In the present study, peaking meant that consumption in a 15 min period exceeded a pre-determined criterion. Peaking could also be defined in terms of the high points in the hourly consumption curves of Figure 3. A third peaking is the high community demand from all the families in an area such as that reported by Iowa Power and Light Company between 8:00 and 11:00 a.m. and between 5:00 and

9:00 p.m. A final definition of peaking is seasonal. Iowa Power and Light Company is a summer time peaking company. Thus, across the entire year, electricity demand is highest in the summer months. Power companies supplying electricity to homes heated by electrical heating devices would be examples of winter peaking companies.

Time of day metering is based on the hourly demand curves of an entire community. Power companies in Florida (e.g., "Peak Load Experiment," 1977) are now assessing the effects of differential rate structures based on time of day use. Peak hour consumption costs more than non-peak hour consumption. This type of research indicates a shift by the power companies from educational or informational approaches to a manipulation of the consequences of electricity consumption. This is a welcome change since providing information about electricity consumption, which typically involves giving watt ratings of various appliances or giving tips on how to save electricity, has been shown to be ineffective in reducing consumption (Hayes & Cone, in press; Winett, et al., in press). Peak pricing is more similar to the behavioral techniques that have been shown to be effective.

Reference Notes

1. Fletcher, W. Personal communication. Iowa Power and Light Company, Des Moines, Iowa, 1977.

2. Woodarski, J. S. The reduction of electrical energy consumption: The application of behavioral analysis. Ninth Annual Meeting, Association for the Advancement of Behavior Therapy, San Francisco, December, 1975.

References

Burgess, R. L., Clark, R. N., & Hendee, J. C. An experimental analysis of anti-litter procedures. Journal of Applied Behavior Analysis, 1971, 4, 71-75.

Chapman, C., & Risley, T. R. Anti-litter procedures in an urban high-density area. Journal of Applied Behavior Analysis, 1974, 7, 377-383.

Clark, R. N., Burgess, R. L., & Hendee, J. C. The development of anti-litter behavior in a forest campground. Journal of Applied Behavior Analysis, 1972, 5, 1-5.

Foxx, R. M., & Hake, D. F. Gasoline conservation: A procedure for measuring and reducing the driving of college students. Journal of Applied Behavior Analysis, 1977, 10, 61-74.

Geller, E. S., Farris, J. C., & Post, D. S. Prompting a consumer behavior for pollution control. Journal of Applied Behavior Analysis, 1973, 6, 367-376.

Geller, E. S., Witmer, J. F., & Orebaugh, A. L. Instructions as a determinant of paper-disposal behaviors. Environment and Behavior, 1976, 8, 417-439.

Hayes, S. C., & Cone, J. B. Reducing residential electrical energy use: Payments, information, and feedback. Journal of Applied Behavior Analysis, in press.

Hayes, S. C., Johnson, V. S., & Cone, J. D. The marked item technique: A practical procedure for litter control. Journal of Applied Behavior Analysis, 1975, 8, 381-386.

Kohlenberg, R., & Phillips, T. Reinforcement and rate of litter depositing. Journal of Applied Behavior Analysis, 1973, 6, 391-396.

Kohlenberg, R., Phillips, T., & Proctor, W. A behavioral analysis of peaking in residential electrical energy consumers. Journal of Applied Behavior Analysis, 1976, 9, 13-18.

Meyers, A. W., Artz, L. M., & Craighead, W. E. The effects of instructions, incentive, and feedback on a community problem: Dormitory noise. Journal of Applied Behavior Analysis, in press.

Palmer, M. H., Lloyd, M. E., & Lloyd, K. E. An experimental analysis of electricity conservation procedures. Journal of Applied Behavior Analysis, in press.

Peak load experiment proved no easy task. Orlando Sentinel Star, May 15, 1977, Sec. B, p. 3.

Powers, R. B., Osborne, J. G., & Anderson, E. G. Positive reinforcement of litter removal in the natural environment. Journal of Applied Behavior Analysis, 1973, 6, 579-586.

Seaver, W. B., & Patterson, A. H. Decreasing fuel oil consumption through feedback and social commendation. Journal of Applied Behavior Analysis, 1976, 9, 147-152.

Winett, R. A., Kagel, J. H., Battalio, R. C., & Winkler, R. C. The effects of monetary rebates, feedback, and information on residential electricity conservation. Journal of Applied Behavior Analysis, in press.

Winett, R. A., Kaiser, S., & Haberkorn, G. The effects of monetary rebates and daily feedback on electricity. Journal of Environmental Systems, 1976, 6, 327-339.

Winett, R. A., & Nietzel, M. T. Behavioral ecology: Contingency management of consumer energy use. American Journal of Community Psychology, 1975, 3, 123-133.

APPENDIX

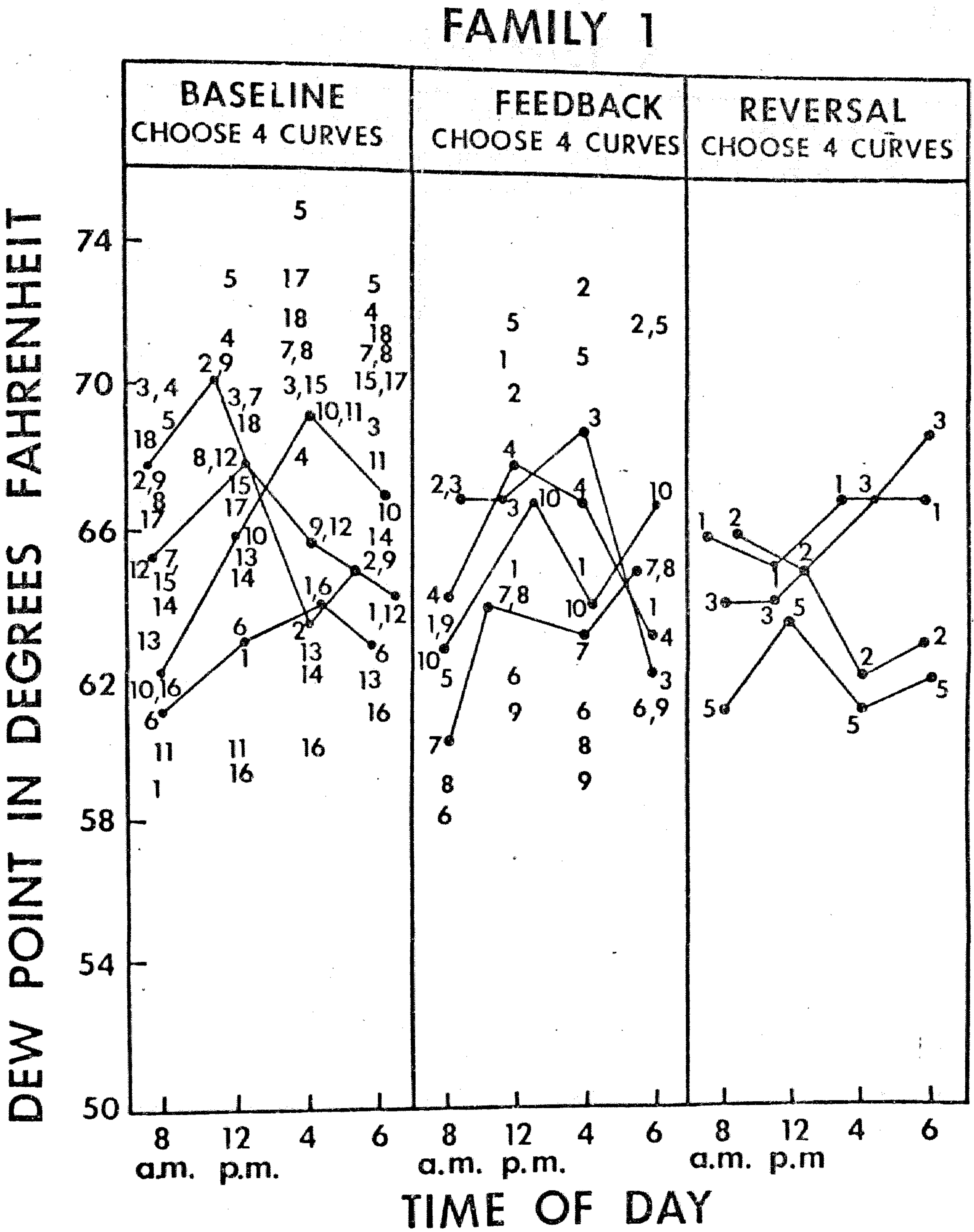

Figure 4. The dew point reading at 8 a.m., 12 noon, 4 p.m., and 6 p.m. for all humid days (days with a median dew point of 60° or above) for Family 1. Each number represents a certain day in each condition. The connected numbers are the equated days chosen by the judges.

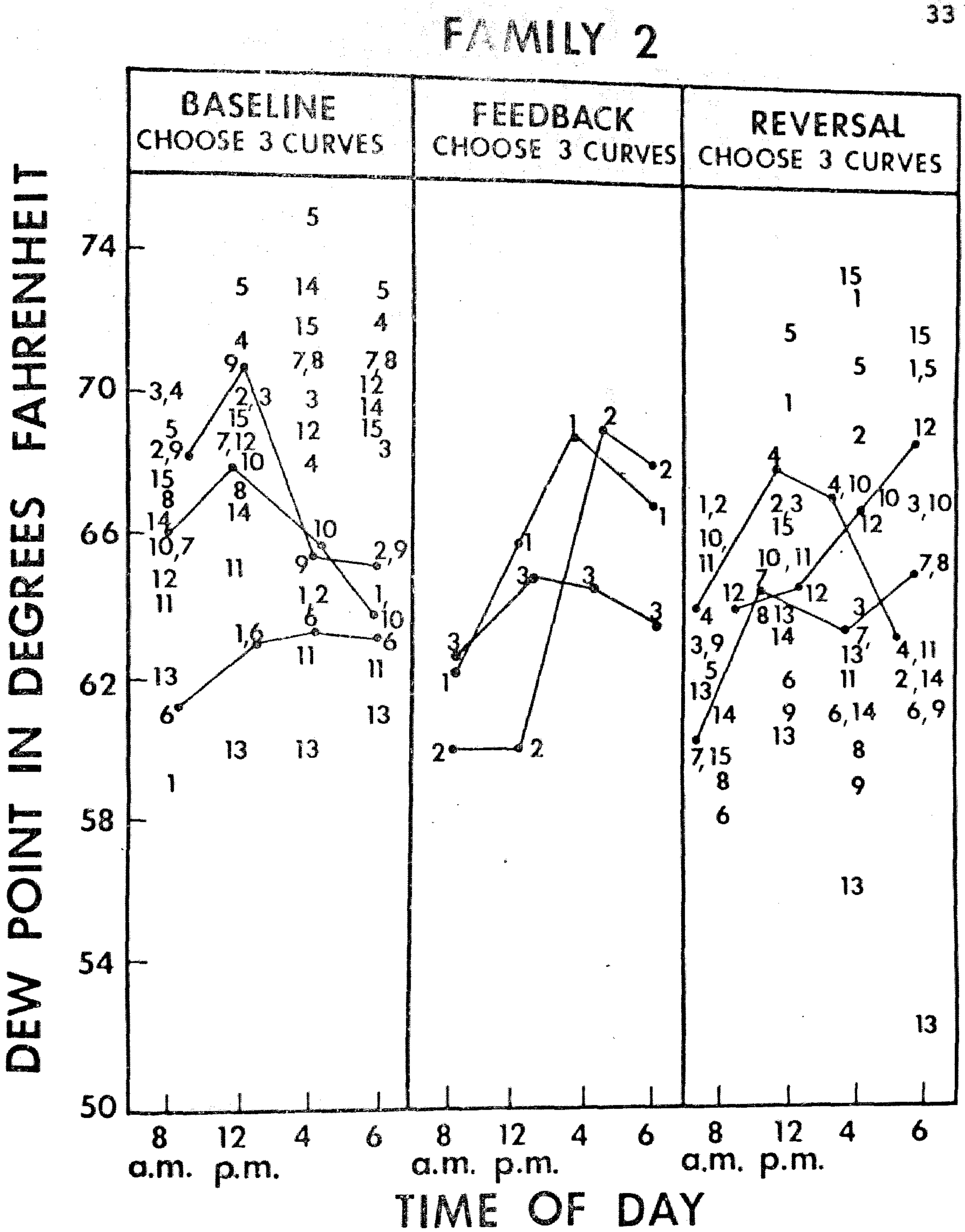

Figure 5. The dew point reading at 8 a.m., 12 noon, 4 p.m., and 6 p.m for all humid days (days with a median dew point of 60° or above) for Family 2. Each number represents a certain day in each condition. The connected numbers are the equated days chosen by the judges.

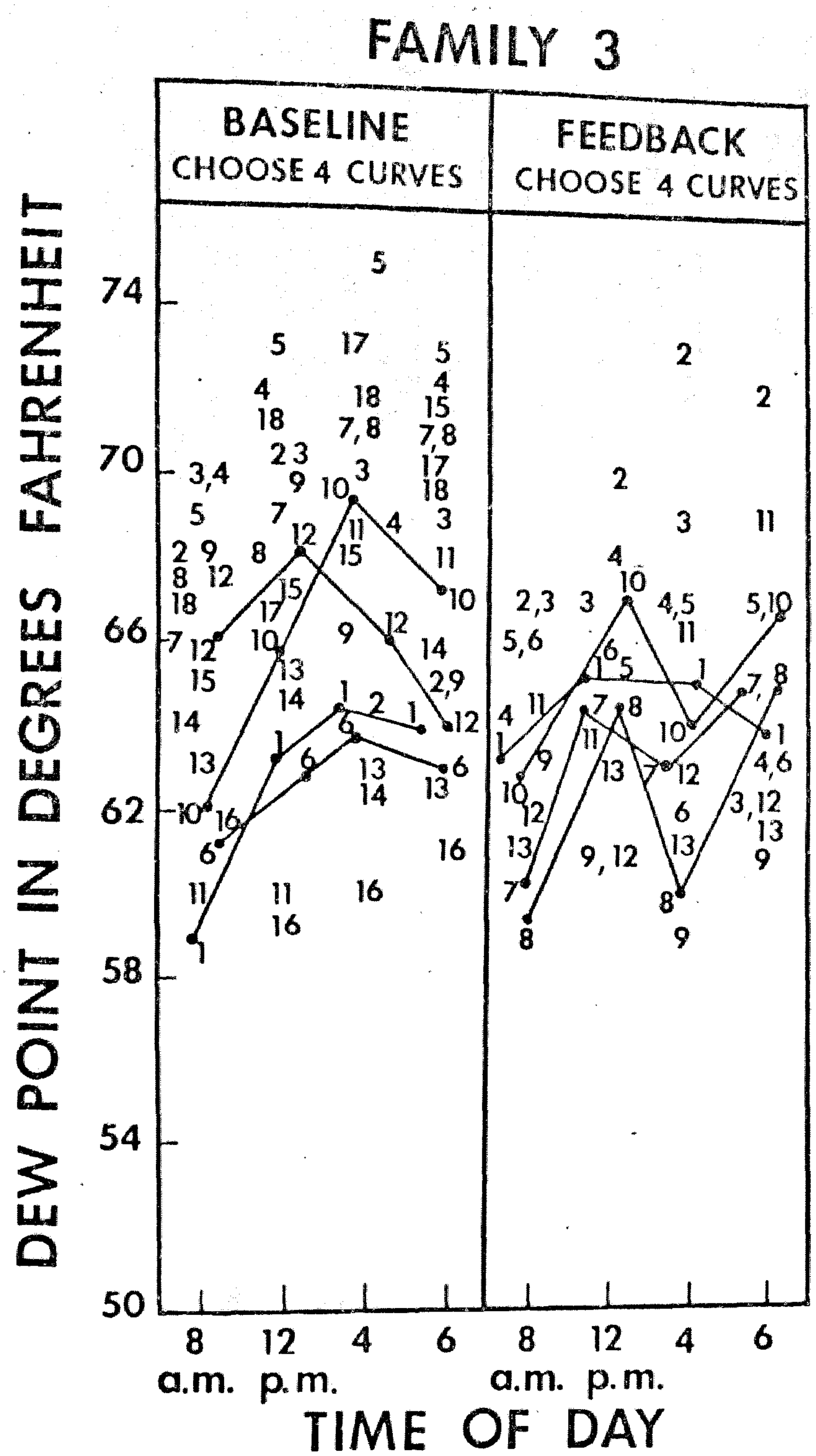

Figure 6. The dew point reading at 8 a.m., 12 noon, 4 p.m., and 6 p.m. for all humid days (days with a median dew point of 60° or above) for Family 3. Each number represents a certain day in each condition. The connected numbers are equated days chosen by the judges.

Table 4

The dependent variable, independent variables, design, whether consumption was related to heating or cooling and the order of effectiveness of the independent variables for each of the eight studies listed

Study	Dependent variable	Independent variables	Design	Was consumption related to heat or cooling	Order of effectiveness of independent variables
Hayes & Cone, in press	KWH/hour	Rebates--weekly for less KWH use Feedback--daily monetary Information--watt rating & conservation tips	Single subject & multiple baseline	no	1. Rebates=Rebates+ Feedback=Rebates+ Information 2. Feedback 3. Information (temporarily eff.)
Kohlenberg, Phillips, Proctor, 1976	Cumulative energy units over a peak criterion	Rebates--bi-weekly for less KWH Feedback--every 15 min Information--peaking explained & watt ratings	Single subject	No	1. Rebates+Feedback 2. Feedback 3. Information (not effective)
Palmer, Lloyd, & Lloyd, in press	KWH/day	Feedback--daily KWH Monetary Feedback--KWH & ~~cost~~ projections Prompt--daily or letter from government office	Single subject	No	1. No differences found between any independent variables

Table 4 (continued)

Study	Dependent variable	Independent variables	Design	Was consumption related to heat or cooling	Order of effectiveness of independent variables
Seaver & Patterson, 1976	# gallons of fuel oil per degree day	Feedback--recent use compared to previous winter's use Commendation--less recent use given "We are saving oil" decal	Between groups--2 oil deliveries used	Yes (heating)	1. Feedback+commendation 2. Feedback (not effective when compared to control group)
Winett, Kagel, Battalio, & Winkler, in press	% reduction in power use (read weekly)	Rebates--High & low (weekly) Feedback--weekly meter reading Information--conservation tips	Between & within groups	Yes (cooling)	1. High rebate+feedback+information 2. Low rebate+feedback+info. 3. Feedback (not effective) 4. Information (not effective)
Winett, Kaiser, & Haberkorn, 1976	KWH/day charted as % changed	Rebates--High & low for reduced use--given weekly Feedback--daily % change in KWH use	Between & within group (within group was ABCD)	Yes--on some days (cooling)	1. High rebates+feedback 2. Low rebates+feedback as effective as feedback

Table 4 (continued)

Study	Dependent variable	Independent variables	Design	Was consumption related to heat or cooling	Order of effectiveness of independent variables
Winett & Nietzel, 1975	% energy reduction (KWH & cubic feet of gas)	Rebates--weekly for % energy reduction Information--electricity and gas reducing tips	Between & within group (within group was ABA)	yes--for part of the study (heating)	1. Rebate+information 2. Information 3. No control groups & weather variation confound results
Woodarski, 1975	Duration of appliance use	Point system--daily points given for less appliance use & for specific behaviors--points exchanged weekly	Single subject--1 family used	Yes (heating)	1. Point system reduced TV, stereo, oven use 2. Point system did not reduce furnace--weather confounding